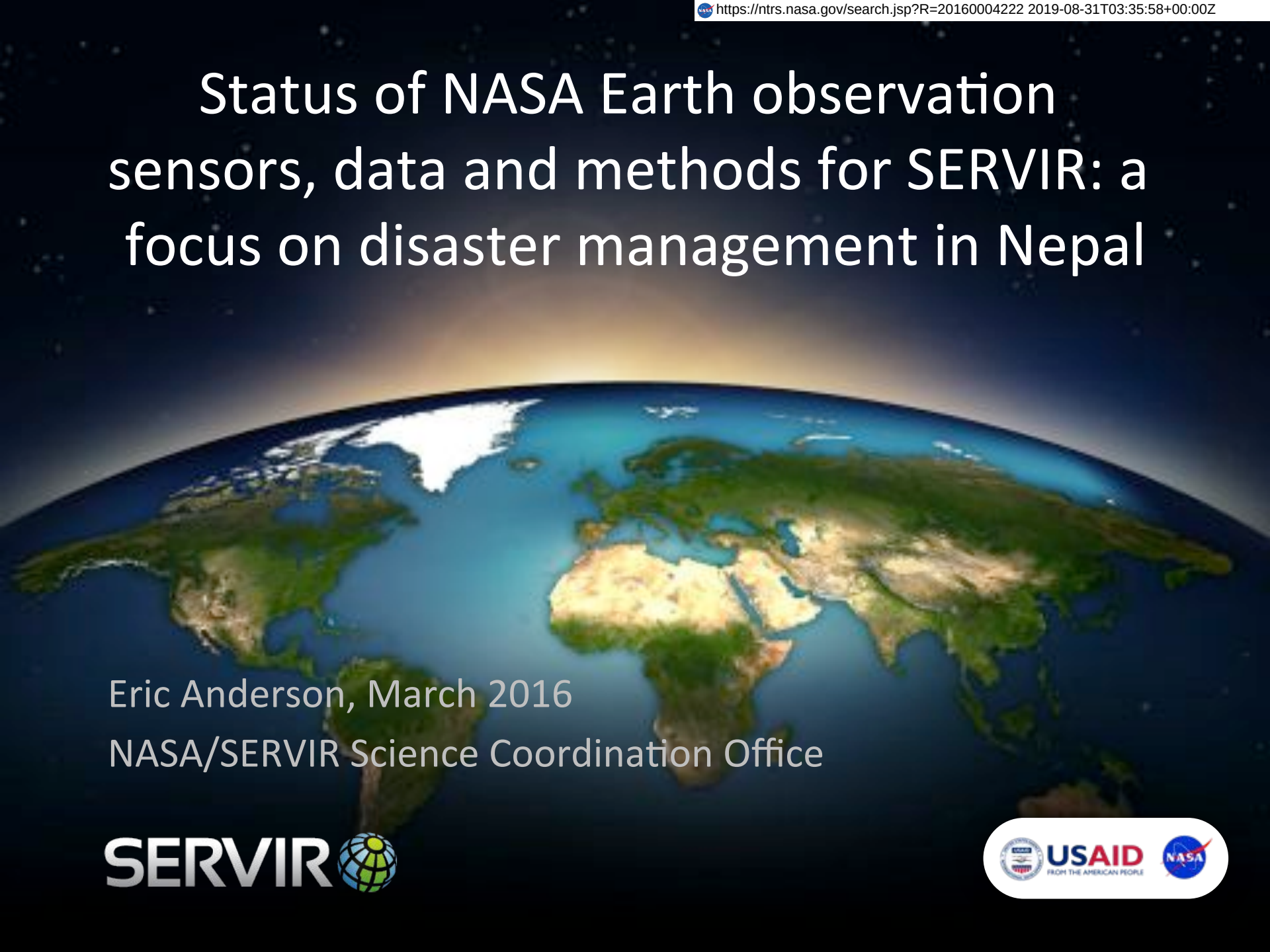
Status of NASA Earth observation sensors, data and methods for SERVIR: a focus on disaster management in Nepal



Eric Anderson, March 2016

NASA/SERVIR Science Coordination Office

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SERVIR: Linking Science to End User Needs

- SERVIR is a link between research institutions and end user decision making.
- SERVIR efforts are led by the needs of the region. Some examples include hydrologic modeling, crop yield estimation, land cover change detection, and hydro-meteorological hazard monitoring

- Presence of SERVIR Hubs, such as ICIMOD, RCMRD, and ADPC, with regional governmental support, makes the linkage sustainable.

Outline

Satellite missions and value-added products

- Landsat series
- ASTER and EO-1
- VIIRS Day-night Band
- *Under Study:* SWOT (Surface Water and Ocean Topography) mission
- *Under Study:* NISAR (NASA-ISRO Synthetic Aperture Radar) mission
- SRTM-2 DEM for various applications

Data services and processing systems

- ClimateSERV data processing system for water resources management
- GPM and SMAP missions for rainfall and hydrology applications

Hazard and disaster event monitoring and response support

- NASA and ICIMOD disaster response support for the Nepal earthquake
- Glacial lake and landslide hazards

Satellite missions and value-added products

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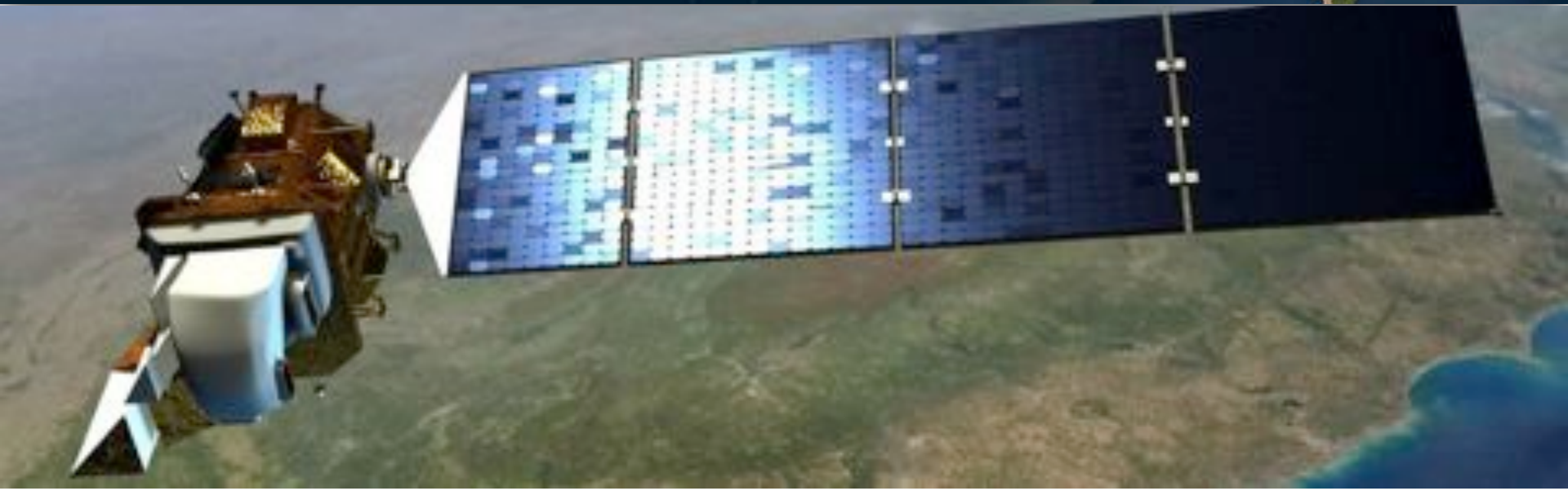
Landsat series

- Continuous 40+ year record of terrestrial ecosystem variables
- Further science and applications with Sentinel-2 (ESA)
- Landsat 8 higher level products available upon request from http://earthexplorer.usgs.gov
  - Surface reflectance (atmospheric correction)
  - Land surface temperature
  - http://landsat.usgs.gov/CDR_LSR.php

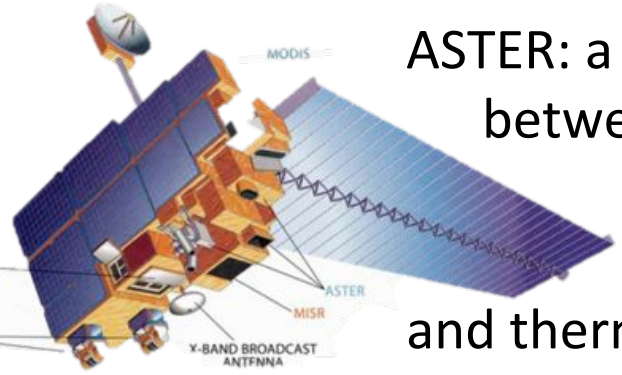
The Landsat Mission continues…



Planned to launch in 2023, Landsat 9 will continue the longest space-based record of Earth's land—past the half century mark.

- https://www.nasa.gov/press/2015/april/nasa-usgs-begin-work-on-landsat-9-to-continue-land-imaging-legacy
- http://landsat.gsfc.nasa.gov/?p=10391

ASTER sensor and EO-1 satellite

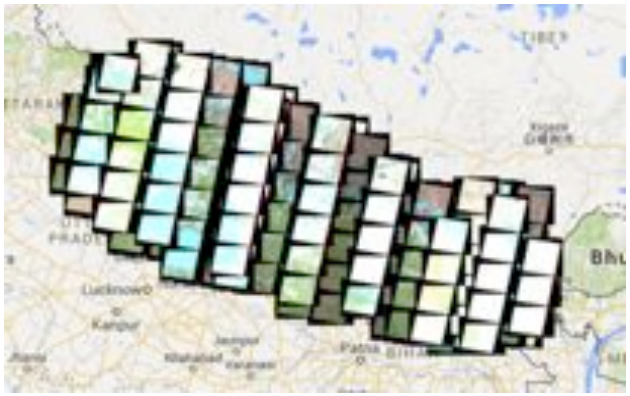


ASTER: a collaboration between NASA and JAXA; visible-near infrared and thermal, on board Terra satellite

- 2000 to present

EO-1 (Earth Observing-1): a validation mission for Landsat continuity (ALI) and hyperspectral land imaging (Hyperion)

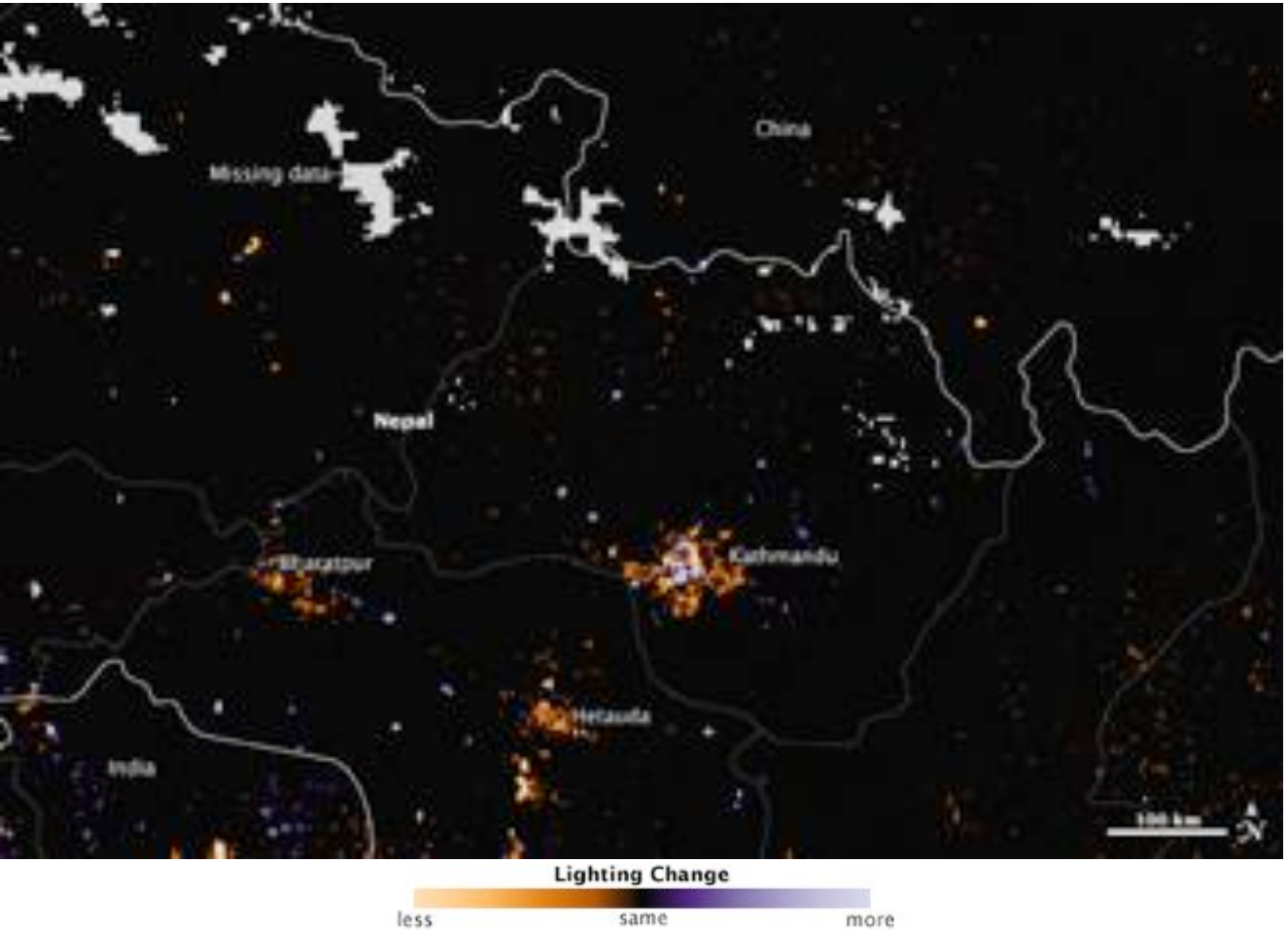
- 2001 to present



Both have offered targeted and expedited imaging for specific SERVIR areas of interest

http://earthexplorer.usgs.gov

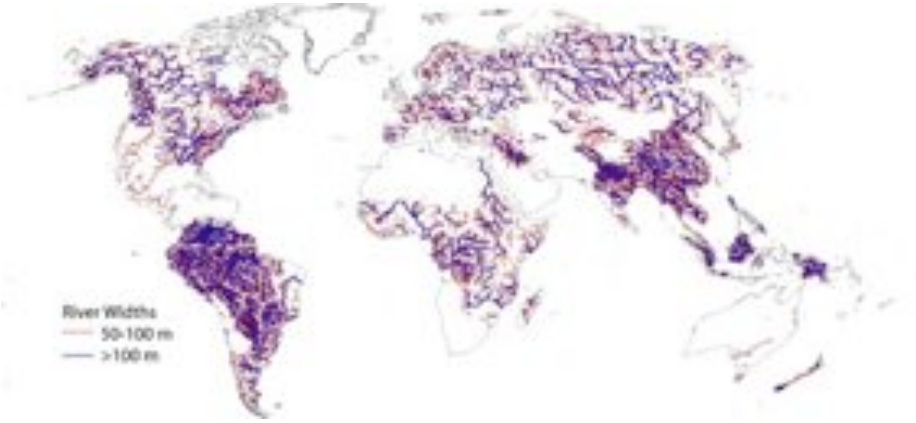
VIIRS Day-Night Band on Suomi NPP Satellite



Visible Infrared Imaging Radiometer Suite (VIIRS) sensor on the Suomi NPP satellite, shows how the amount of light emitted by towns and cities in Nepal changed before and after the earthquake. (NASA/SPoRT)

Under Study: SWOT - Surface Water and Ocean Topography mission

- New key objectives for hydrology
  - Global inventory and change patterns of surface water bodies >250m^2 and rivers >10km long and >100m wide
  - 21 day repeat coverage; accuracy within 10cm



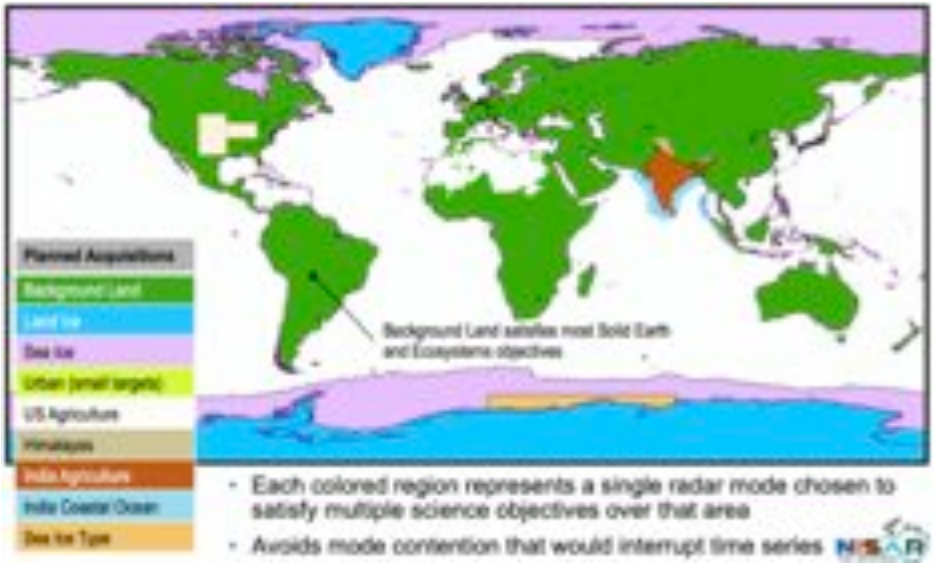
Pavelsky et al., 2014
http://dx.doi.org/10.1016/j.jhydrol.2014.08.044

- Science application to improve river discharge estimates
- 2020 launch planned

https://swot.jpl.nasa.gov/applications/

Under Study: NISAR NASA-ISRO Synthetic Aperture Radar) mission

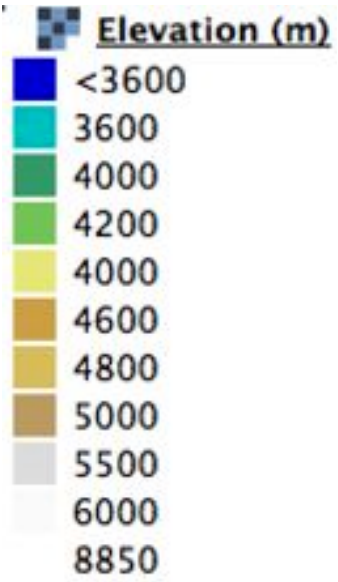
- A dedicated U.S. and Indian InSAR mission, in partnership with ISRO, optimized for studying hazards and global environmental change.
  - ecosystem disturbances, ice-sheet collapse, and natural hazards such as earthquakes, tsunamis, volcanoes and landslides
- L-band and S-band also provide data for ecosystem and agricultural monitoring
- 2020 launch planned



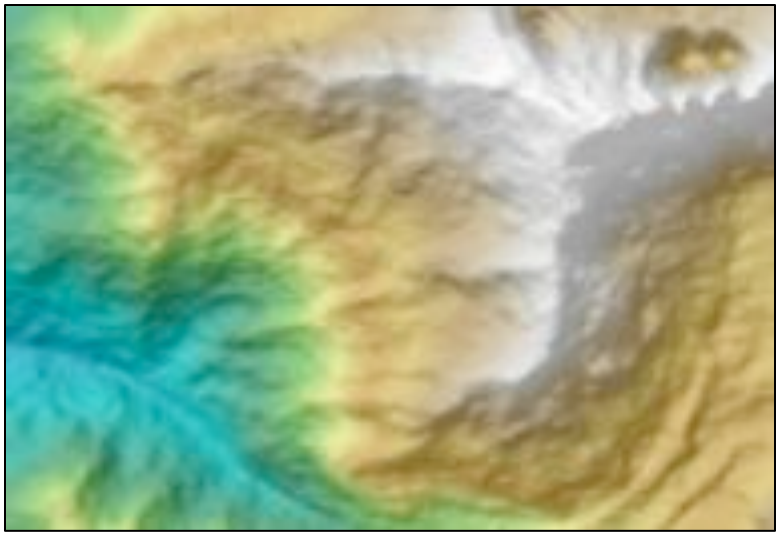
http://nisar.jpl.nasa.gov

SRTM-2 30m Digital Elevation Model

- Global 1 arc second (30m) elevation data
  - Freely available through http://reverb.echo.nasa.gov/ and https://lpdaac.usgs.gov/



SRTM (90m)



SRTM (30m)

Data services and processing systems

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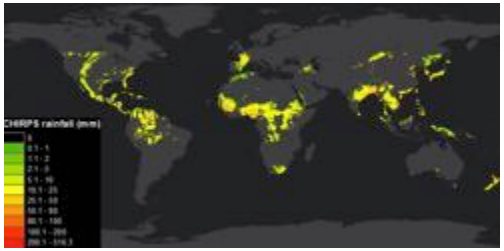
ClimateSERV

http://ClimateSERV.nsstc.nasa.gov/



Many users do not need global data for each day, instead need only information for their geographic area of interest and for their time period of interest.

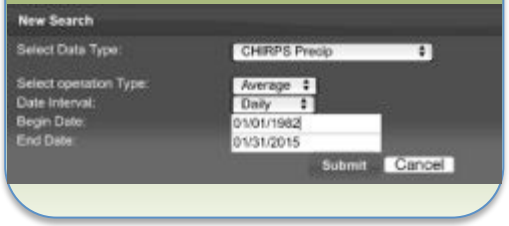
SERVIR has built the ClimateSERV data processing system to analyze and deliver global or regional data for the time period and area of interest.

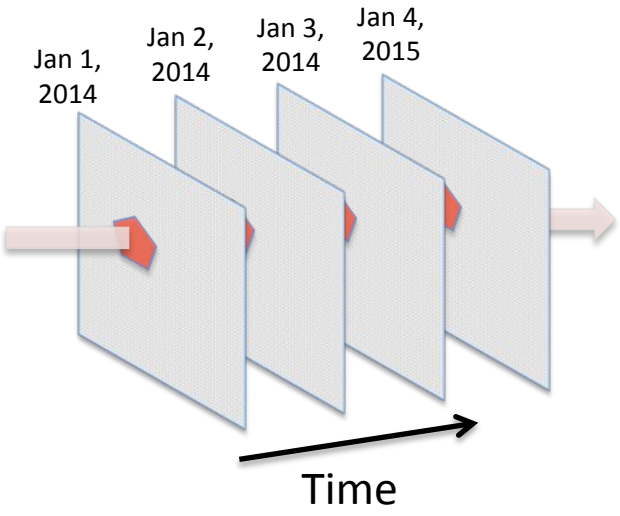
- *Built on the following free and open datasets:*
  - CHIRPS global rainfall data (FEWS NET)
    - 0.05° spatial resolution (~5 km)
    - Consistent, daily rainfall records since 1981
  - NMME Seasonal climate forecasts (NASA/SERVIR)
    - 0.5° spatial resolution (~50 km).
    - Daily rainfall and temperature for 180 days in advance, updated monthly
  - eMODIS vegetation index (NDVI, for West Africa, USGS)
    - 250 m spatial resolution. Pentadal, available since 2001

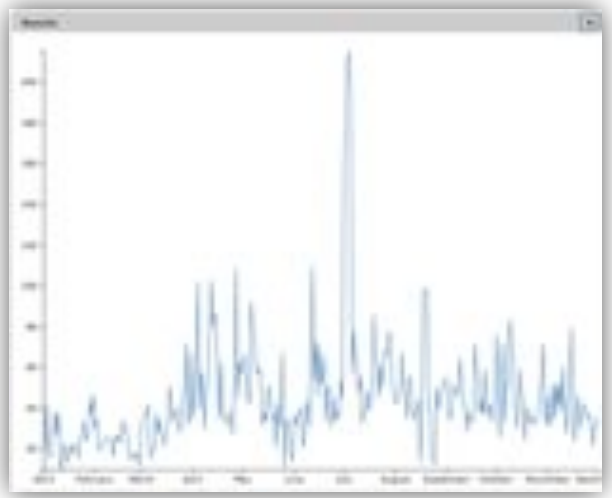
ClimateSERV Data Processing

Create Area of Interest
Or choose predefined geometry

Select parameters, data type and date ranges

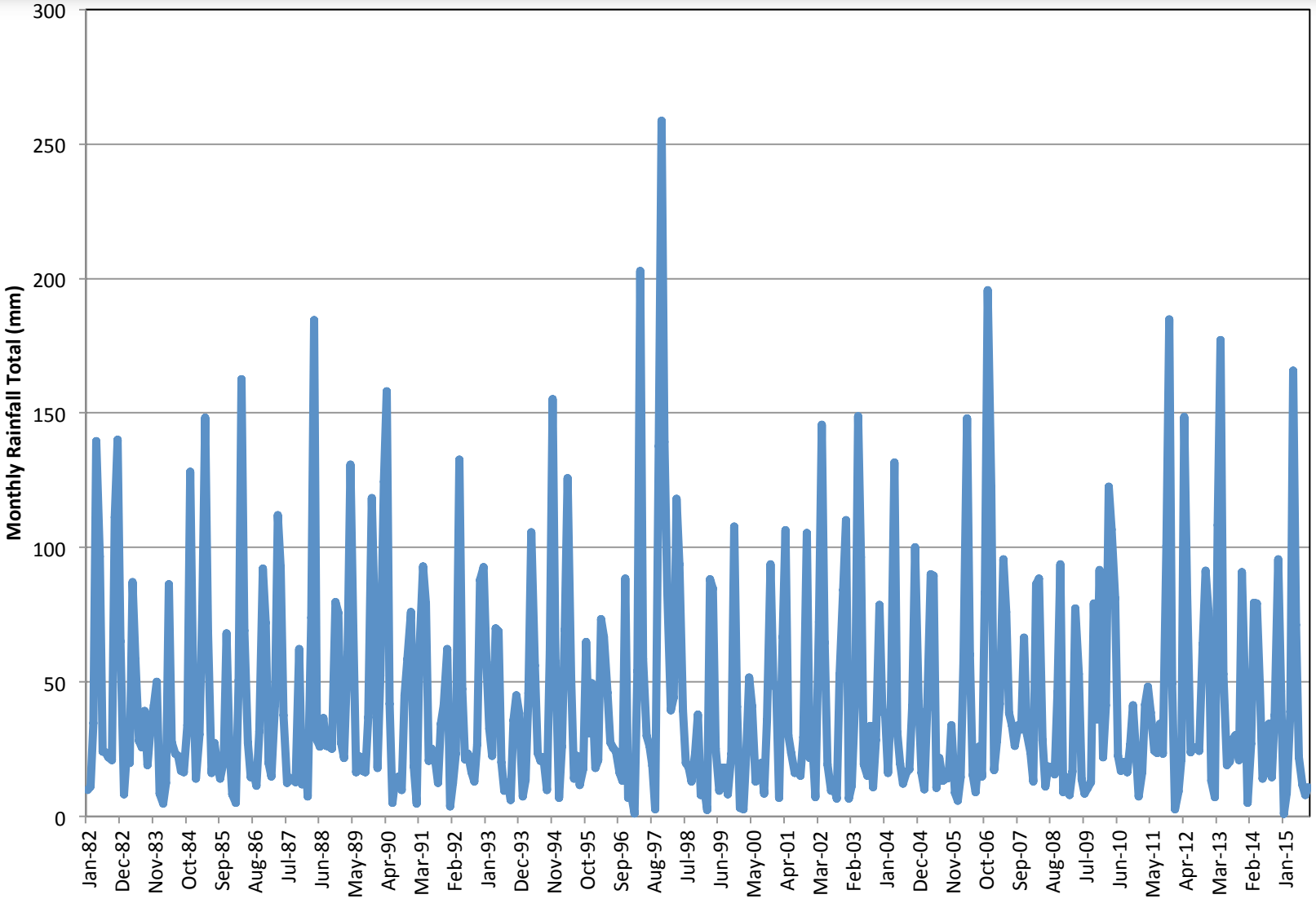






Ashutosh Limaye
NASA/SERVIR Project Scientist

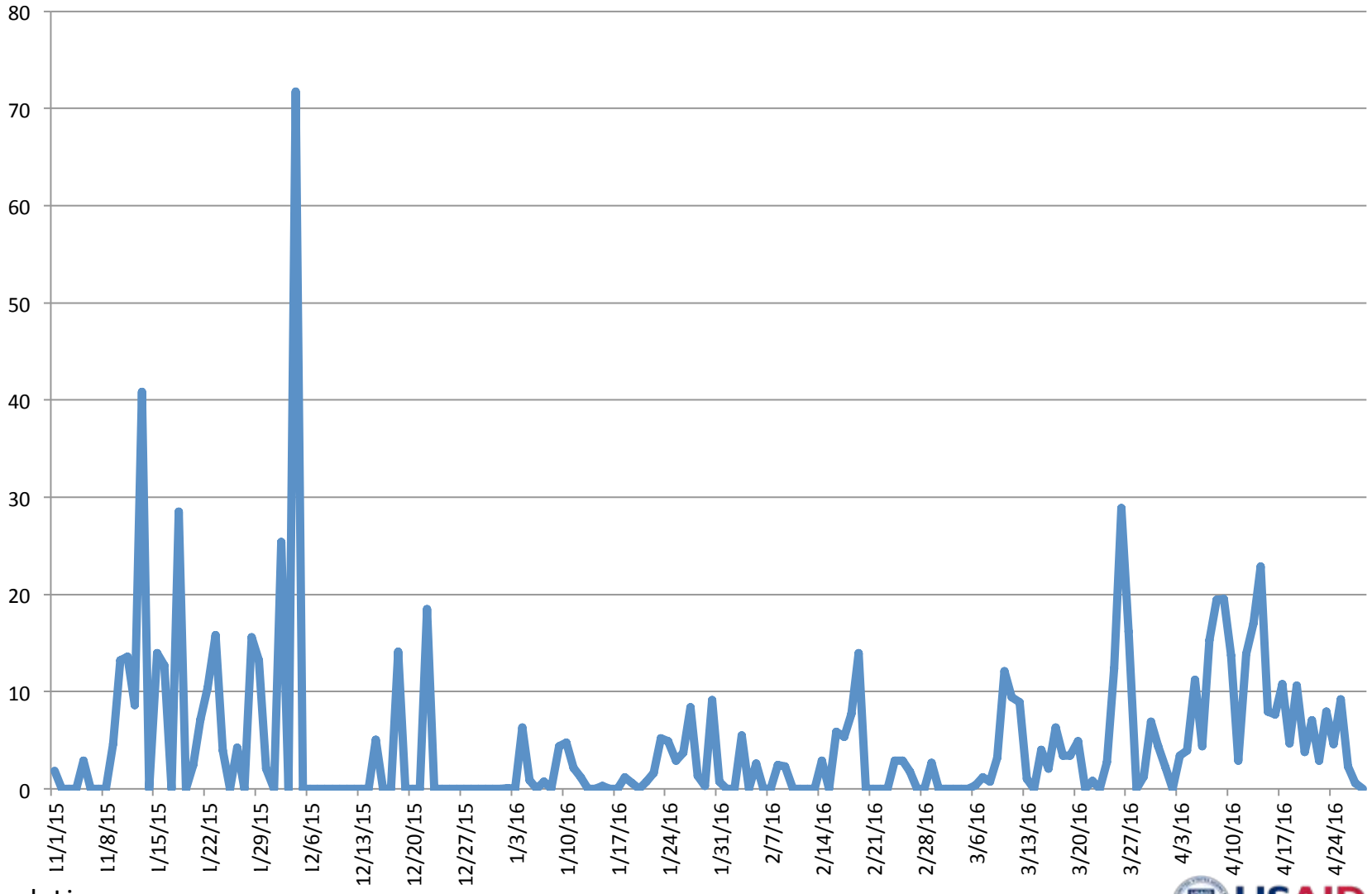
ClimateSERV
Kenya CHIRPS Monthly Rainfall



Ashutosh Limaye
NASA/SERVIR Project Scientist

ClimateSERV

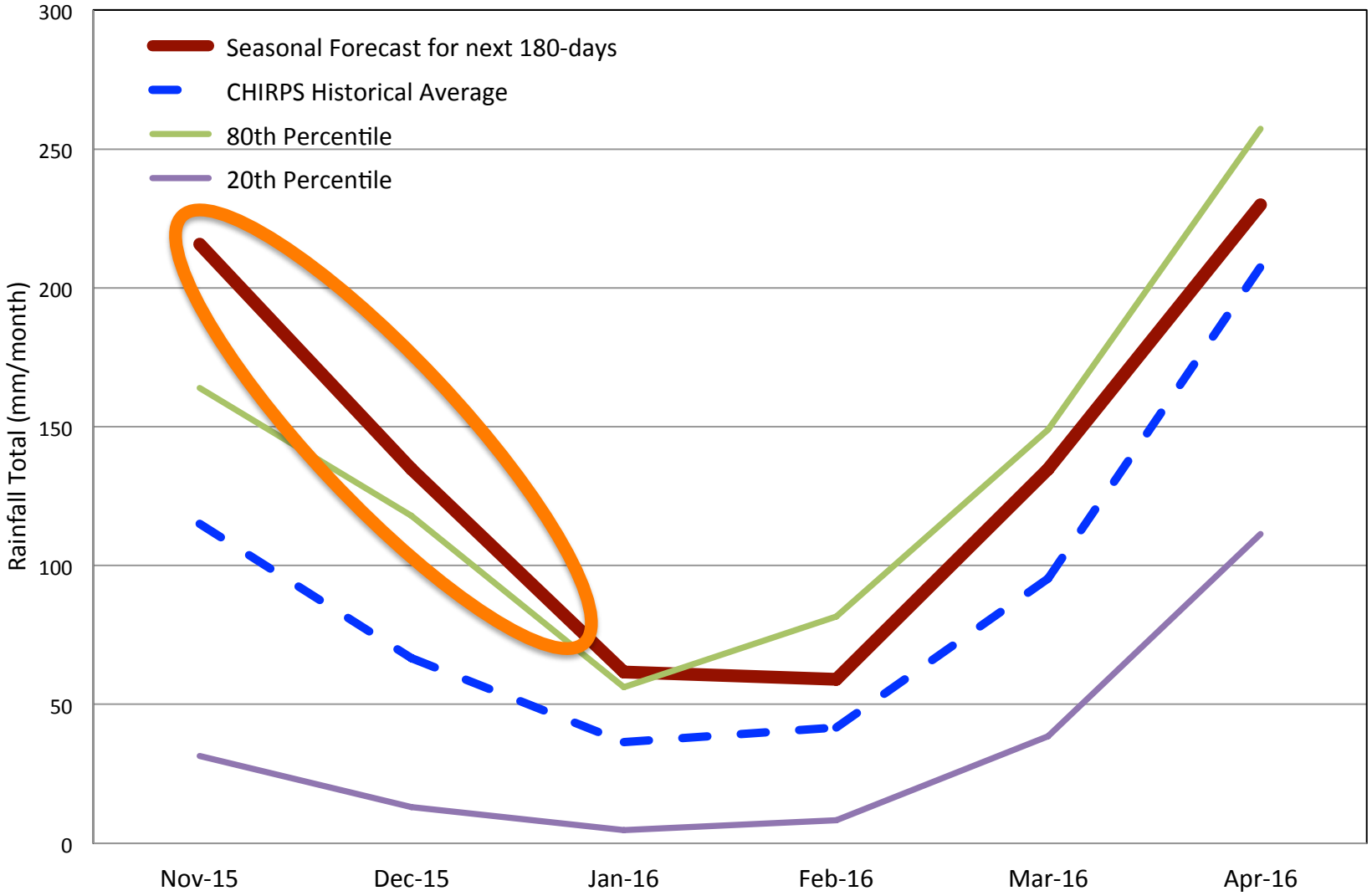
Seasonal Forecast for Kenya, 1 Nov 2015 - 28 Apr 2016



Ashutosh Limaye
NASA/SERVIR Project Scientist

ClimateSERV

Monthly Rainfall for Kenya for next 180 days Combining CHIRPS and Seasonal Rainfall Forecasts



Ashutosh Limaye
NASA/SERVIR Project Scientist

Next Steps and Request for Feedback on ClimateSERV

- We are adding more functionality to this portal.
  - Multiple ensembles on the same plot, download
  - Cumulative rainfall
  - Combined historical perspective on the forecast plots

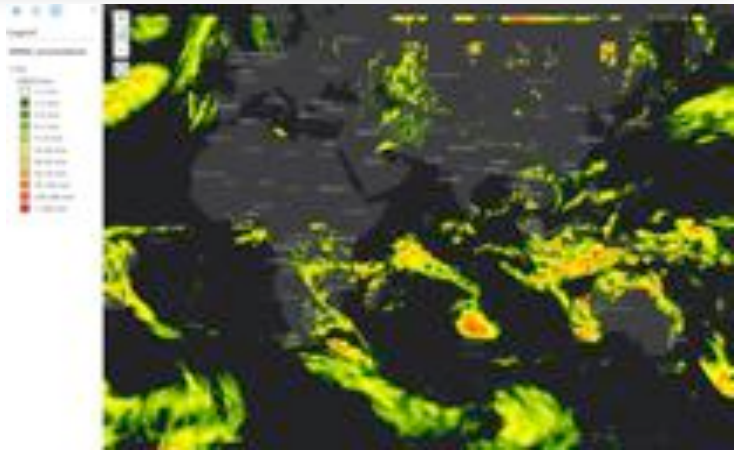
- We request you to use this system to see whether it provides the desired capabilities.
  - Request you to send what you would like to see added

- Two types of feedback requested via email
  - Functionality on existing features (statistics, data processing, plotting, raw data access)
  - Additional features, and datasets

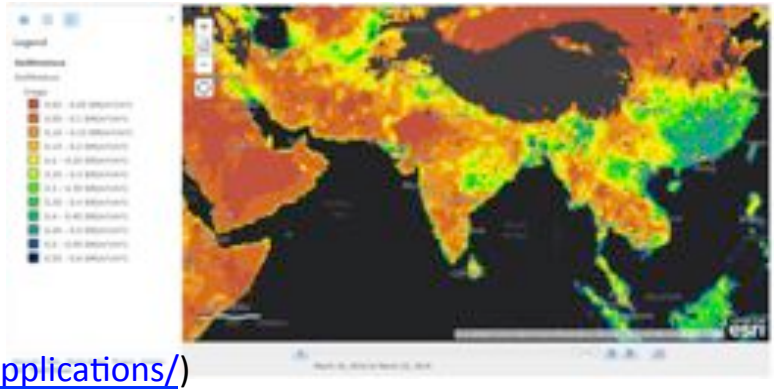
Ashutosh Limaye
NASA/SERVIR Project Scientist

GPM – Global Precipitation Measurement Mission
SMAP – Soil Moisture Active-Passive Mission

- **GPM** IMERG Web Map Service
  - https://servirglobal.net/Global/Articles/Article/1452/servirs-new-web-service-streamlines-use-of-key-precipitation-data
- 0.1°, 30-min precipitation products
- Hydrology applications
  - Floods (http://pmm.nasa.gov/applications/floods)
  - Landslides (http://pmm.nasa.gov/applications/landslides)



Follow on TRMM-based flood and landslide monitoring
http://pmm.nasa.gov/TRMM/flood-and-landslide-monitoring



- **SMAP** applications (http://smap.jpl.nasa.gov/science/applications/)
  - monitoring soil moisture to improving understanding of water cycle, weather and climate forecasting, droughts, fires, floods, landslides, and agricultural productivity
  - Web map service: http://gis1.servirglobal.net/arcgis/rest/services/Global/SoilMoisture/MapServer

Hazard and disaster event monitoring and response support

NASA and interagency response support to 2015 earthquake

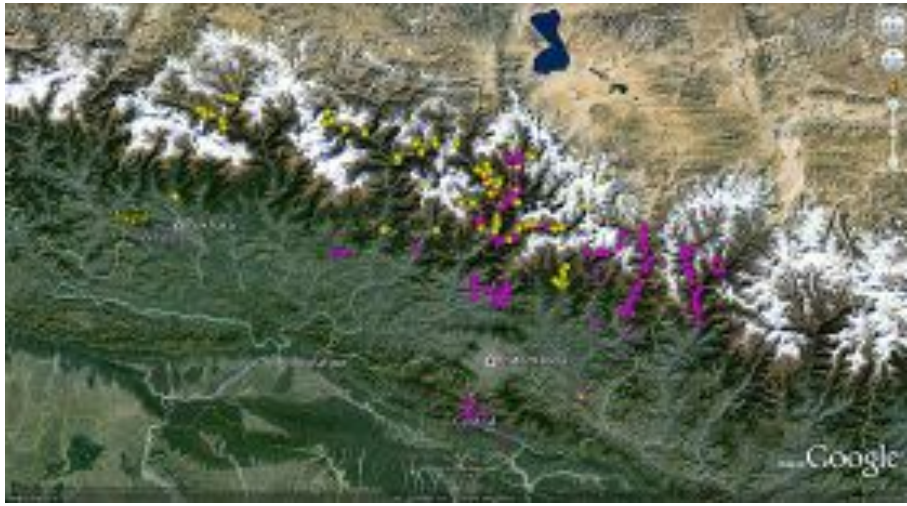
http://weather.msfc.nasa.gov/sport/disasters/gorkha/

Support for disaster response efforts after Nepal earthquake

GIS/remote sensing experts at ICIMOD and volunteers preparing maps for earthquake disaster response

Nepal's Deputy Prime Minister, Minister of Home Affairs, other senior gov. officials visit ICIMOD

- 23,000+ "tiled" NASA and commercial satellite images to ICIMOD in Nepal
- Satellite tasking recommendations



4000+ landslides identified by the NASA-USGS-ICIMOD Interagency Volunteer Earthquake Response Team (incl. SERVIR Applied Science Team PIs Kargel and Kirschbaum) (Kargel et al. 2016)

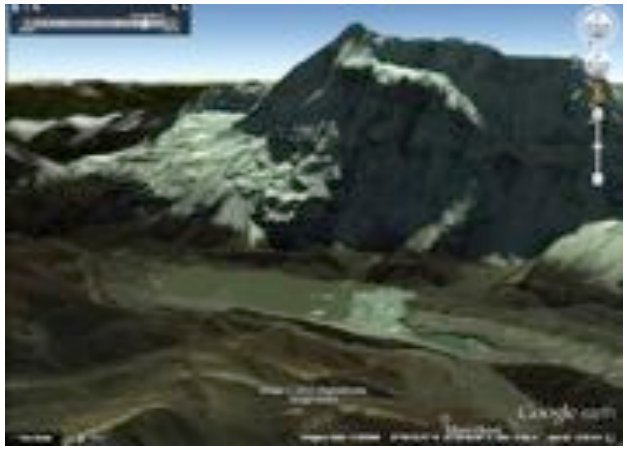
http://www.nasa.gov/mission_pages/servir/software-developed-by-servir-interns-aids-nepal-earthquake-response.html
Images from http://www.icimod.org/?q=17851 and https://www.facebook.com/icimod

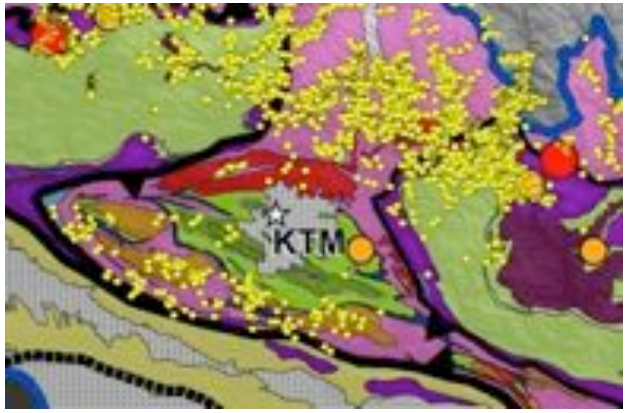
Glacier and Alpine Hazards in Relation to Development and Habitation in the Hindu Kush-Himalaya

Jeffrey S. Kargel, Gregory Leonard, Umesh Hairitashya, Dhananjay Regmi, Michael Bishop, and Dan Shugar, other "Landslide Volunteers"

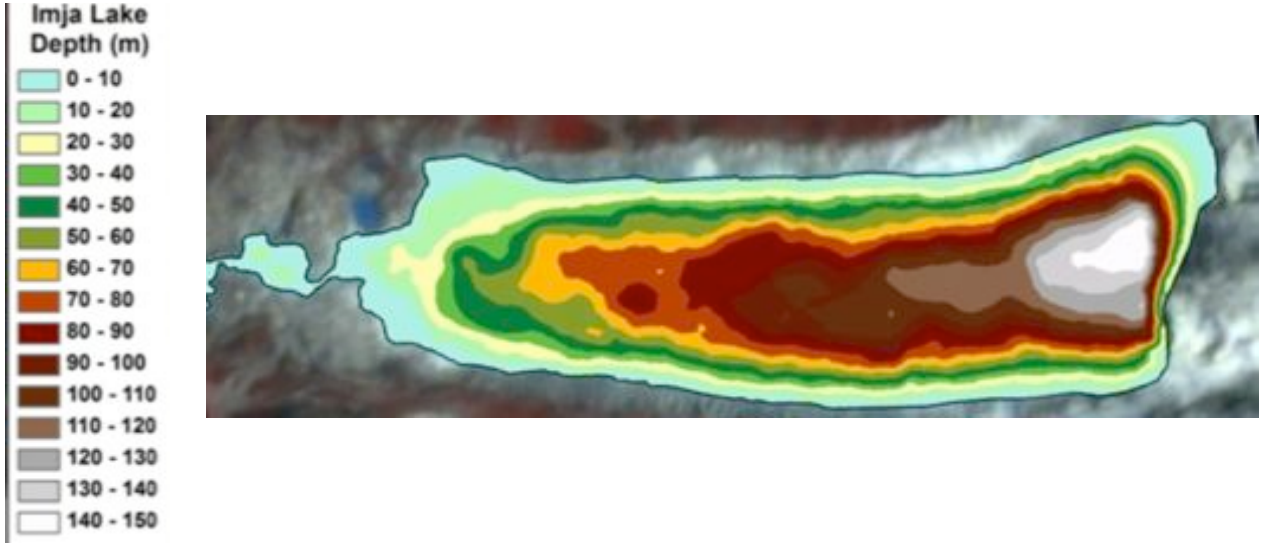
A "SERVIR Applied Sciences Team" Project.
Main activities:

- Satellite and field assessment of mountains hazards and disasters and their process chains (lakes, glaciers, outburst floods, earthquake-induced landslides)
- Field and remote sensing investigation of Lower Barun Lake (one of Nepal's most dangerous).
- Assessments/datasets: Seti River disaster, earthquake-induced landslides, and glacier lakes bathymetry and hazards





Kargel et al., 2016. *Science*.



http://catalogue.servirglobal.net/Product?product_id=14

Landslide Hazard Assessment and Forecasting System using near real-time remote sensing information over HKH region

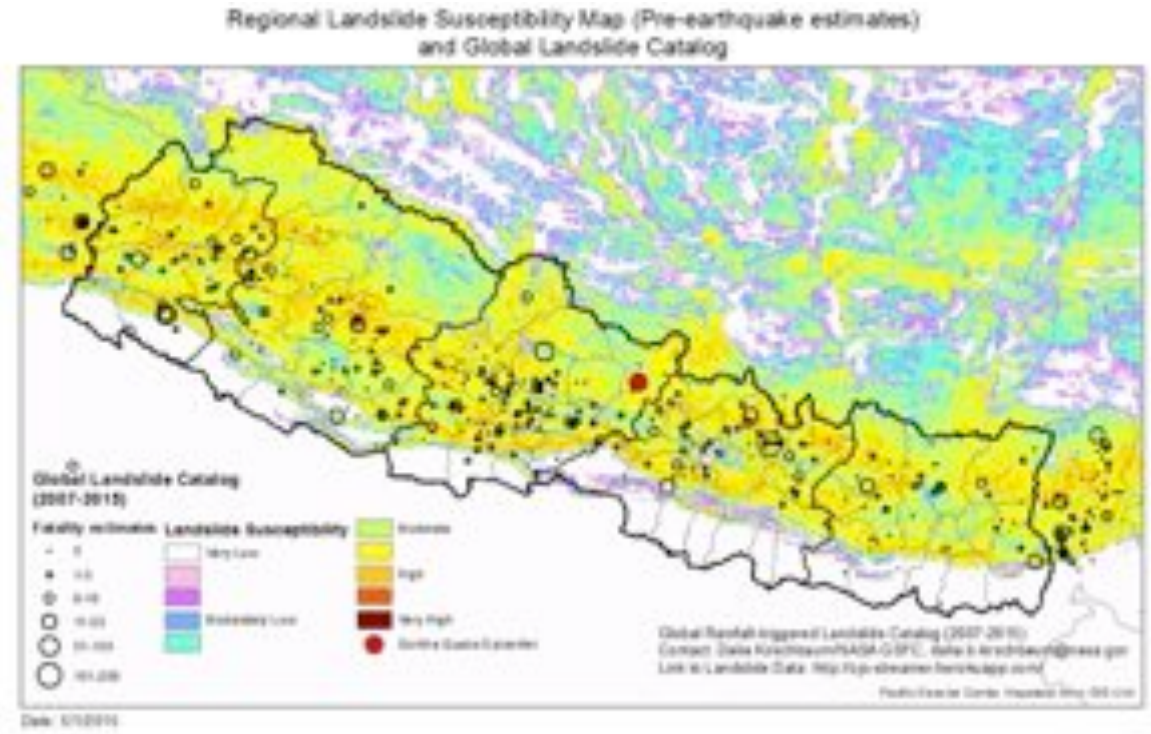
Dalia Kirschbaum, NASA Goddard Space Flight Center; Jose Cepeda, Norwegian Geotechnical Institute; Stuart Frye, SGT/GSFC; Sujay Kumar, SAIC/GSFC, Joe Santanello, NASA GSFC

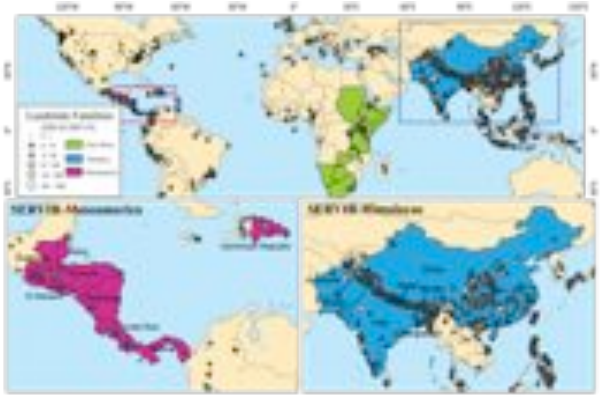
A "SERVIR Applied Sciences Team" Project. Objectives:

- Landslide susceptibility and exposure mapping
- Calculation of rainfall thresholds
- Automation of daily landslide hazard in online platform
- Feasibility test and prototype system for Nepal

Now open source: https://github.com/vightel/ojo-processing/tree/master/python

http://ojo-streamer.herokuapp.com/nepal





Global Landslide Catalog

Relevant Publications:

Kirschbaum, D.B., Stanley, T., Zhou, Y., 2015. Spatial and Temporal Analysis of a Global Landslide Catalog. Geomorphology. doi:10.1016/j.geomorph.2015.03.016

Kirschbaum, D.B., Stanley, T., Yatheendradas, S., 2015. Modeling Landslide Susceptibility over Large Regions with Fuzzy Overlay. Landslides. doi: 10.1007/s10346-015-0577-2

Kirschbaum, D.B., Stanley, T., Simmons, J., *in review,* 2015. A Dynamic Landslide Hazard Assessment System for Central America and Hispaniola. Nat. Hazards Earth Syst. Sci. 1–32.

Kirschbaum, D.B. Cappelaere, P., Frye, S., Mandl, D., Stanley, T., *in preparation*, 2015. Multi-scale, Multi-architecture for Disasters and Science. Computers & Geoscience.

http://catalogue.servirglobal.net/Product?product_id=29

Thank you

Eric Anderson, NASA/SERVIR Science Coordination Office

eric.anderson@nasa.gov

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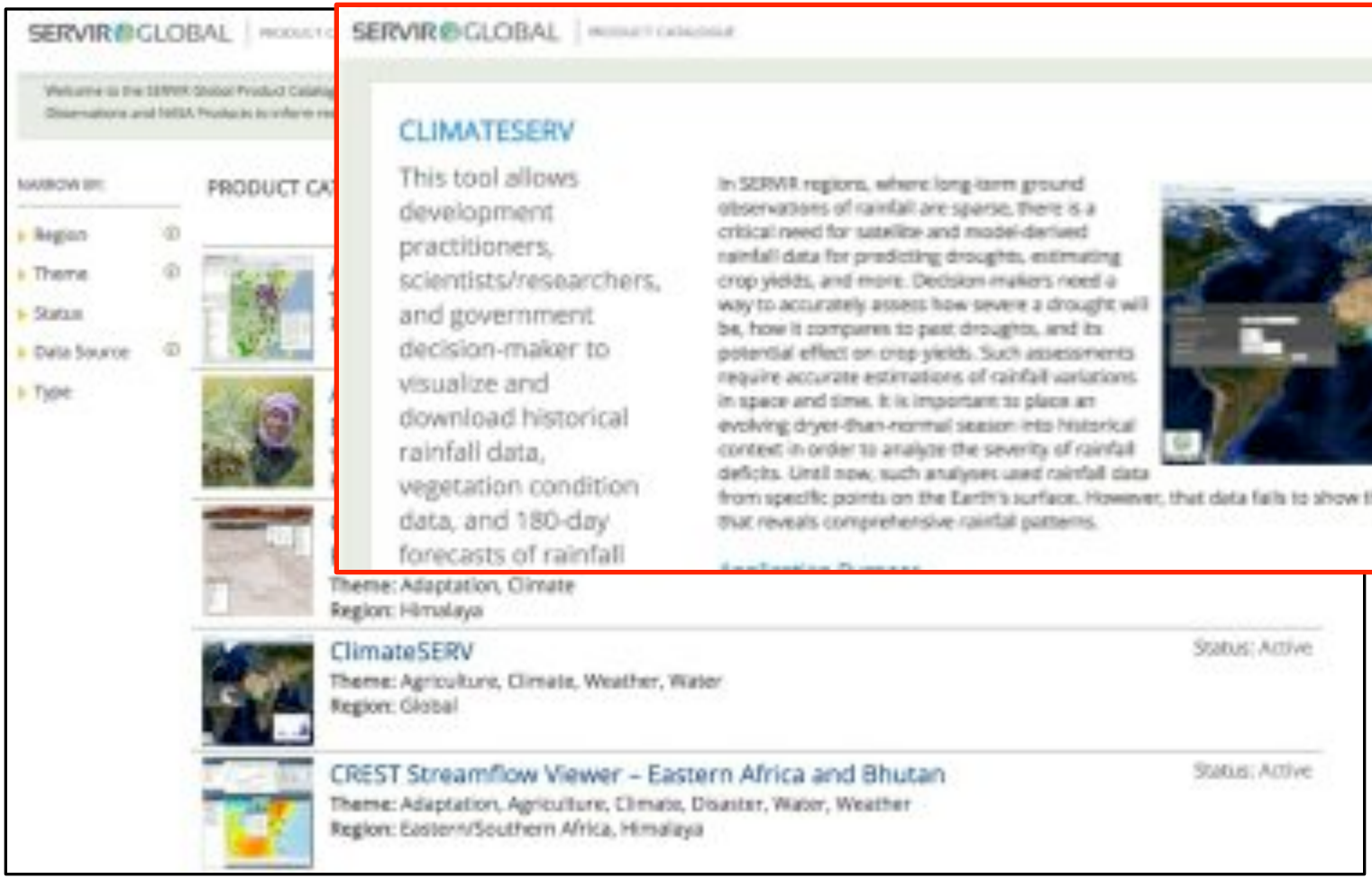
SERVIR Product Catalog



http://servircatalog.net / http://servircatalogue.net

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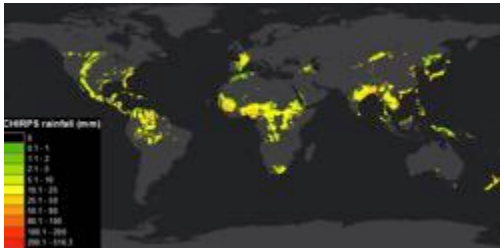
Backup slide:
ClimateSERV input data details

http://ClimateSERV.nsstc.nasa.gov/



- CHIRPS global rainfall data (FEWS NET)
  - 0.05° spatial resolution (~5 km)
  - Consistent, daily rainfall records since 1981
  - Funk et al., 2015 doi:10.1038/sdata.2015.66 2015 and several others
- NMME Seasonal climate forecasts (NASA/SERVIR)
  - 0.5° spatial resolution (~50 km).
  - Daily rainfall and temperature records for 180 days in advance.
  - Updated every month, around the 10th of the month
  - Robertson et al., 2015 http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150000716.pdf
  - Sikder et al., 2016 http://dx.doi.org/10.1175/JHM-D-14-0099.1
- eMODIS vegetation index (NDVI, for West Africa, USGS)
  - 250 m spatial resolution. Pentadal, available since 2001

Backup slide:
ClimateSERV input data availability

The CHIRPS, eMODIS, and NMME data are available from a variety of sources

- Famine Early Warning System (FEWS NET)
  - CHIRPS: ftp://chg-ftpout.geog.ucsb.edu/pub/org/chg/products/CHIRPS-2.0/
  - eMODIS: http://earlywarning.usgs.gov/fews
- NOAA National Centers for Environmental Prediction (NCEP)
  - http://www.cpc.ncep.noaa.gov/products/NMME/
  - http://iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/